State of Utah

JON M. HUNTSMAN, JR.
Governor

GARY R. HERBERT
Lieutenant Governor

Department of Administrative Services
D'ARCY DIXON PIGNANELLI
Executive Director

Division of Facilities Construction and Management
F. KEITH STEPAN
Director

ADDENDUM

Date:	17 March 2006
To:	Contractors
From:	Dan Clark, Project Manager, DFCM
Reference:	Brigham City UDOT Maintenance Station
DFCM Project #:	05059900
Subject:	**Addendum No. 1**

Pages		
	Addendum	1 page
	Architectural Addendum	5 pages
	Revised Spec. Section 03053	1 page
	Footing Detail	1 page
	Geotechnical Report	39 pages
	Total 8.5x 11 pages	47 pages

16 ea (24x36) Addendum #1 Drawings are available on the DFCM Project Web page; http://dfcm.utah.gov/main.php?project_number=05059900

Note: This Addendum shall be included as part of the Contract Documents. Items in this Addendum apply to all drawings and specification sections whether referenced or not involving the portion of the work added, deleted, modified, or otherwise addressed in the Addendum. Acknowledge receipt of this Addendum in the space provided on the Bid Form. Failure to do so may subject the Bidder to disqualification.

1.1 Schedule changes: There are no schedule changes per this Addendum.

1.2 Reference the attached addendum items and 16 D size revised drawings.

End of Addendum

ARCHIPLEX GROUP

addendum 1

DATE: March 17, 2006

DFCM Project No.: 05059900
Archiplex Group Project No.: 050013.01

ADDENDUM NO. 1 to the Contract Documents for the Construction of UDOT Maintenance Station 1423, Brigham City, Utah.

The contents of this addendum supersede the information contained in the original Contract Documents and are hereby incorporated therein. Unless otherwise so stated, any changes herein offset only the specific drawings, words, or paragraphs mentioned, and the balance of the drawings and specifications remain in full force.

A. QUESTIONS RECEIVED:

1. **Q**. Where are the Building Snow Loads?
   A. See Specification 13125.1.4.C.4

2. **Q**. What type of Stainless finish is required on the (2) work benches located in the Maintenance Bay and do the seams have to be welded?
   A. There are (3) work benches shown in the Maintenance Bay area. Two on the South wall @ 6'-6" wide each & 1 on the West wall @ 8'-0" wide. Provide 1 continuous Stainless Steel top with a 304 finish at each location, if a seam is required it must be welded and ground smooth.

3. **Q**. I have submitted information to have my metal building manufacturer pre-approved.
   A. The following four (3) additional metal building manufacturers have been pre-approved based on information provided: Braemar Building Systems, Nucor Building Systems, and Chief Industries, Inc. It is indicated in the specifications that manufacturers must meet all three of the following qualifications at a minimum: 1) Member of MBMA, 2) have obtained AISC Certification for Category MB for an AISC-Certified Facility, Category I, and 3) take engineering responsibility for the metal building. This pre-approval does not in any way waive or modify any of the project specification requirements.

4. **Q**. I am requesting pre-approval for Hager Locks and Closers (Hager hardware is already approved) and Hadrian Metal Lockers.
   A. Hager Locks and Closers and Hadrian Metal Lockers are pre-approved. This pre-approval does not in any way waive or modify any of the project specification requirements.

5. **Q**. Are Architectural wall panels with exposed fasteners acceptable?
   A. Yes, Specification 13125.2.3.4 Should read "Architectural wall panel, 36" wide, 22 gauge minimum, smooth with ribs at 12" o.c. with exposed Fasteners at 12" o.c.

horizontal. Metallic Building Company, "PBR" wall panel or prior approved equal.

6. **Q**. Where is the Geotechnical Report?
   A. This was not included with the Specifications. We have enclosed it at the end of this Document.

B. DESCRIPTION OF ADDENDUM ITEMS:

1. **The project includes the following two (2) additive alternates in the order listed below:**

   a. **Alternate 1**: Liquid Penetrating silane and oliophobic concrete sealer in lieu of base bid.

   b. **Alternate 2**: Integral Xypex concrete admix in addition to Alternate #1. See attached Specification Section 03053 – Concrete Waterproofing System-Add Alternate #2 which clarifies this alternate.

2. **General Information:**

   a. As discussed and requested by the Bidders in the prebid meeting, an allowance for the project utility connections is provided below. Nonetheless, the Bidders are responsible for delivering a completed project to the State of Utah including all utility and service connections. The actual final cost of these items is still the responsibility of the Bidder, this is information DFCM has researched for the benefit of the Bidders:

   UTILITY CONNECTION ALLOWANCE: The project utility connection allowance cost for this project will be $7,500. This includes connection fees for power, propane, sewer, telephone and water.

3. **Demolition Information:**

   a. Footing Detail (included at end of this document) – shows existing footing & foundation at existing Maintenance Building as originally drawn.
   b. DFCM will be responsible for the demolition fee required by DEQ.

4. **Architectural Addendum Items:**
   Sheet AE101:

   a. Detail D1/AE101 has been revised to show larger column base for Portal Frame.
   b. Added note and dimension to coordinate location & size of concrete pier with Structural Engineer and metal building manufacturer to meet all ADA Requirements.
   c. Exterior window is now shown on Mechanical Mezzanine Plan.
   d. Splash Blocks have been deleted at locations C3 &A3.
   e. Larger Interior Concrete piers at Portal Frame Locations (Grids A1&2 & Grids C1&2)

f. Added Concrete Piers @ Grids B2, B3, B4 & B5
g. Splash blocks at Grids A1, A6, C1 & C6 have been relocated to edge of Concrete apron.
h. General Note 6 refers to Typical Bollard Details. Detail A1/AE502 Shall be used at all interior conditions. Detail B2/AE502 Shall be used at all exterior conditions

Sheet AE121:

a. Exterior window is now shown on Mechanical Mezzanine Reflected Ceiling plan.
b. Radiant Heating layout adjusted as per Mechanical Revisions.

Sheet AE201:

a. Move downspouts to edge of building and rotate end of downspout 90 degrees to align with relocated splash blocks.(Grids A1&6, C1&6)
b. Revise Exterior Color Schedule: Downspouts @ Grids A1&6 & C1&6 shall match trim color, Downspouts @ Grids A3 & C3 Shall match wall panel color.
c. Add Keynote “03300.S1 Splash Block” to Keynote Legend.

Sheet AE301:

a. A1/AE301: Show Concrete Pier @ Grid B

Sheet AE311:

a. Delete splash block from Wall sections A3 & A4/AE311.
b. Revise graphic representation of metal building insulation at roof and wall panels on all wall sections.

Sheet AE502:

a. Revise Detail B2/AE502 to show 18” Dia. Concrete Base for Exterior Bollards.
b. Add Detail A1/AE502 to show Pipe Bollard Detail @ interior Conditions.

5. Structural Addendum items:

Sheet S101:

a. Added concrete piers for the columns in the center of the building.
b. Changed the pier references for the portal and braced frames at Grids 1/A, 2/A, 1/C, and 2/C.

Sheet S501:

a. Added the note to detail A1 to chamfer concrete pier corners

Sheet S502:

a. Detail B2 was updated to shown the concrete piers for the center columns

Sheet S601:

a. The concrete pier schedule, detail C2, was updated to for the changes as noted for sheet S101.

6. **Mechanical Addendum items:**

Sheet M201

a. Relocated furnace and associated ductwork and condenser.
b. Defined minimum distance from wall to radiant heater.

7. **Plumbing Addendum items:**

Sheet P201

a. Changed piping to hose bibbs from 1/2" to 3/4".
b. Added two air line drops in the center columns of the bays.

Sheet P301

a. Relocated water heater and furnace and associated piping.

8. **Electrical Addendum items:**

Sheet E001

a. Changed to a pole mounted transformer.
b. Changed panel schedule ckt.20 changed from lift to welder 60a, 2p

Sheet E100

a. Moved traffic rated j-box inside the demolition area as shown on drawing.
b. The existing wash rack note has changed to existing brine pump note.

Sheet E301

a. Moved electrical connections for the water heater, furnace.
b. Changed the outlet previously used for the lift, to a special purpose 208V outlet.

C. ATTACHMENTS:

Footing Detail
Page 1, Specification Section 03053 CONCRETE WATERPROOFING-ADD ALT. 2
Geotechnical Report

D. REISSUED DRAWING LIST:

AE101 First Floor and Mezzanine Plans
AE121 First Floor and Mezzanine Reflected Ceiling Plans
AE201 Exterior Elevations
AE301 Building Sections
AE311 Wall Sections
AE502 Signage and Misc. Details
S101 Footing and Foundation Plan
S501 Footing and Foundation Details
S502 Footing and Foundation Details
S601 Structural Schedules
M201 Mechanical Floor Plan
P201 Plumbing Floor Plan
P301 Plumbing Enlargements
E001 Electrical Schedules and Notes
E100 Electrical Site Plan
E301 Power Floor Plan

SECTION 03053 – CONCRETE WATERPROOFING SYSTEM
ADD ALTERNATE #2

PART 1 - GENERAL

1.01 DESCRIPTION

A. SECTION INCLUDES:

1. This section specifies a complete integral concrete waterproofing system of the slab on grade, stem wall, joints, and penetrations of the facility.

2. This section includes: Furnishing of all labor, materials, services and equipment necessary for the supply and installation of cementitious crystalline waterproofing mixed in concrete prior to placement as indicated on drawings and as specified.

3. This section includes Grout tubes: Furnishing of all labor, materials, services and equipment necessary for the supply and installation of Waterstop with permeable grout tubes where required to prevent leakage through construction cold joints as indicated on drawings and as specified.

4. This section includes: Cleaning of concrete surface. Installation of permeable grout tubes and injection of grout tubes with sealing material.

B. RELATED SECTIONS:

1. Section 03300 – Cast In Place Concrete
2. Section 03053 Concrete Waterproofing System Add Alternative #1
3. Section 07901 - Caulking and Sealants

1.02 SYSTEM DESCRIPTION

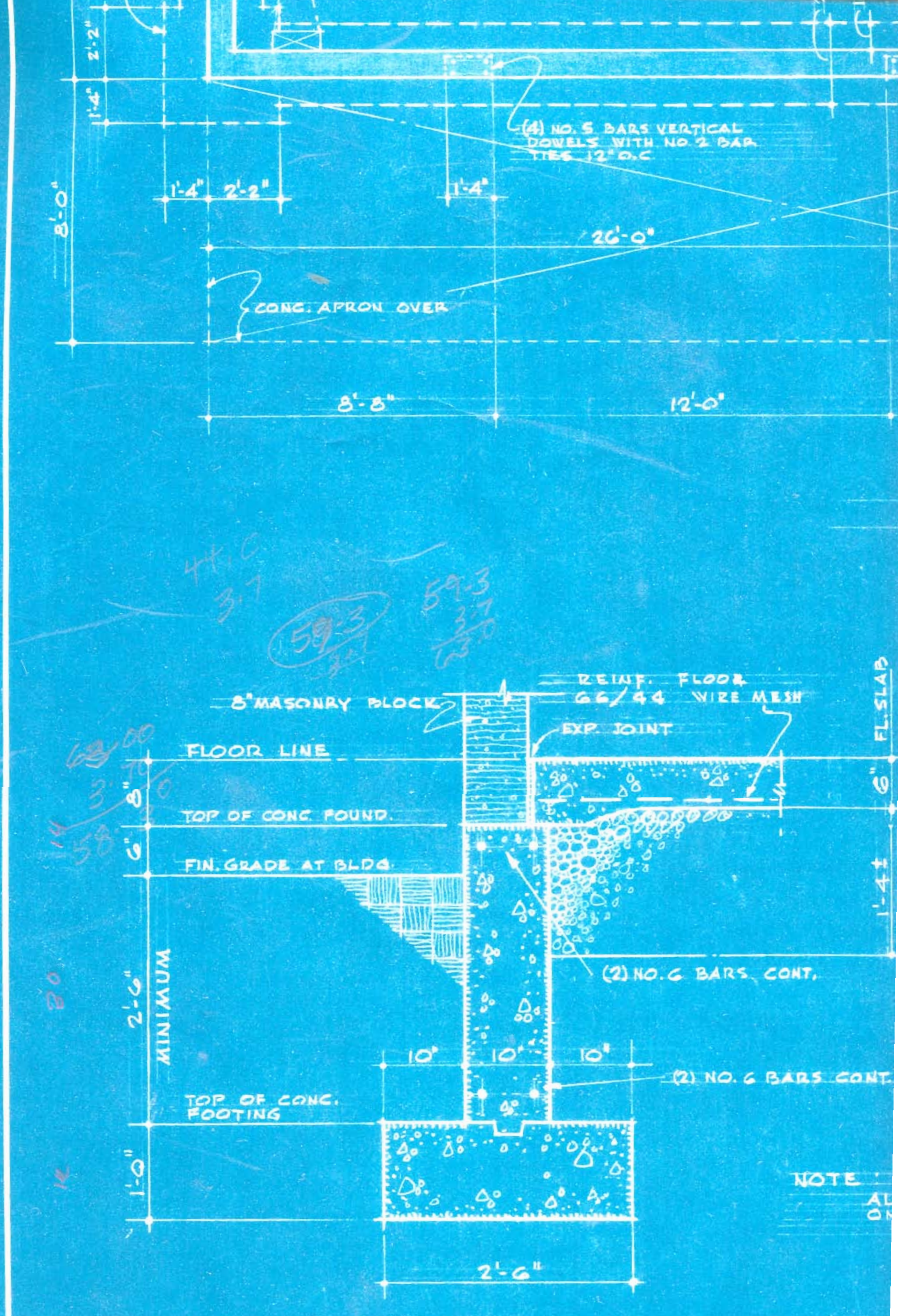
The complete systems include Cementitious Crystalline Waterproofing a blend of Portland cement, fine treated silica sand and active proprietary chemicals. When mixed with water and applied as ***an integral admix*** ~~a cementitious coating,~~ the active chemicals cause a catalytic reaction which generates a non-soluble crystalline formation of dendritic fibers within the pores and capillary tracts of concrete. This process causes concrete to become permanently sealed against the penetration of liquids from any direction in conjunction with the Waterstop-Grout tube system utilizing the injection of uncured polyurethane grout which will expand and cure to a closed cell preventing leakage through construction joints, water penetration and harsh environmental conditions. In addition, the completed systems shall be designed for application on the specified type of surfaces indicated on the project drawings and **warranted for five years** as a total and complete system.

This system is augmented with ADD ALTERNATE #1, ~~Ashford Formula,~~ a Penetrating Liquid Floor Treatment utilizing a clear, breathable, high performance silane concrete sealer with an oliophobic additive for protecting new concrete surfaces. See Section 03053 Concrete Waterproofing System Add Alternative #1.

1.03 SYSTEM PERFORMANCE REQUIREMENTS

A. TESTING REQUIREMENTS:

Crystalline waterproofing system shall be tested in accordance with the following standards and



DETAIL 1/2

SCALE 3/4"=1'-0"

Earthtec Testing & Engineering, P.C.

133 North 1330 West
Orem, Utah - 84057
Phone (801) 225-5711
Fax (801) 225-3363

1596 W. 2650 S. #108
Ogden, Utah - 84401
Phone (801) 399-9516
Fax (801) 399-9842

GEOTECHNICAL STUDY
UDOT MAINTENANCE BUILDING
BRIGHAM CITY, UTAH

Earthtec
Testing and Engineering, P.C.

PREPARED FOR:

JUB ENGINEERING
40 WEST CACHE VALLEY BLVD., BLDG 3B
LOGAN, UT 84341

ETE JOB NO.: 05-2530

OCTOBER 27, 2005

TABLE OF CONTENTS
ETE JOB NUMBER: 05-2530

1.0 INTRODUCTION

We understand that new Maintenance building is planned for the UDOT station located at about 1325 East 200 South in Brigham City, Utah as shown on the Vicinity Map, Figure 1.

This study was made to assist in evaluating the subsurface conditions and engineering characteristics of the foundation soils and in developing our opinions and recommendations concerning appropriate foundation types, floor slabs, and pavements. This report presents the results of our geotechnical investigation including field exploration, laboratory testing, engineering analysis, and our opinions and recommendations. Data from the study is summarized on Figures 2 through 5. A geological hazards evaluation was conducted in conjunction with this report by Western Geologic and a copy is presented in the attached appendix.

2.0 CONCLUSIONS

1. Based upon the three test pits excavated for this study, portions of the site are covered with up to 1 ½ feet of fill soils. Native soils below the fill generally consist of medium dense poorly graded gravel with sand (GP) which extends through the maximum depth investigated (10 feet). Groundwater was not encountered in our test pits at the time of this investigation.

2. Lightly loaded spread footings founded on undisturbed native soils should provide adequate support for the proposed structure. A maximum allowable bearing capacity of 2500 psf should be used for footing design.

3. Pavements should consist of 3.5 inches of asphaltic concrete over 8 inches of untreated aggregated base.

3.0 PROPOSED CONSTRUCTION

We understand that the planned project will consist of razing the existing maintenance building and construction of a new one. The planned building will be of similar size and single story with a slab-on-grade floor placed at or near existing grades. Compressive loads associated with the proposed structure are anticipated to be in the range of 2 to 5 kips per lineal foot for walls, less than 100 kips for columns, and 300 pounds per square foot for the floor slab loads. For pavement design, we used a daily traffic load of 30 18-kip equivalent single axle loads ESAL's. If structural loads or traffic loads are different than those assumed, we should be notified and allowed to reevaluate our recommendations.

4.0 SITE CONDITIONS

The proposed site of the new building is located north of the existing maintenance building in an existing storage area. The area in nearly level with the southern portion covered with asphalt and the northern portion covered with gravel fill. A large power line travels over the site from east to west. Little vegetation was present on the property. The site is bound by the existing maintenance building to the south, a gravel pit to the north and east, and undeveloped land to the west.

5.0 FIELD INVESTIGATION

The field investigation consisted of excavating three test pits to depths of 7 ½ to 10 feet below current site grades. Test pits TP-1 and TP-2 were excavated near the northwest and southeast corners of the proposed building as identified by our client. Test pit TP-3 was excavated north of the proposed building along the existing fence line at the location of the proposed septic system. The soils encountered at the site were continuously logged by the undersigned engineer. Disturbed samples were obtained and returned to our laboratory for testing. Two percolation tests were performed in test pit TP-3 by a state wastewater systems program certified individual.

6.0 LABORATORY TESTING

The samples obtained during the field investigations were sealed and returned to our laboratory where representative samples were selected for laboratory testing. Laboratory tests included a natural moisture determination and a grain size distribution analysis. The results of these tests are shown on Figure 2, attached.

Samples will be retained in our Ogden laboratory for 30 days following the date of this report at which time they will be disposed of unless a written request for additional holding time is received prior to the disposal date.

7.0 SUBSURFACE CONDITIONS

Based upon the three test pits excavated for this study, portions of the site are covered with up to 1 ½ feet of fill soils. Native soils below the fill generally consist of medium dense poorly graded gravel with sand (GP) which extends through the maximum depth investigated (10 feet). Groundwater was not encountered in our test pits at the time of this investigation. Graphical representations of the soil conditions encountered are shown on the Test Pit Logs, Figures 2 through 4. A legend of the symbols used on the test pit logs is shown on Figure 5.

8.0 SITE GRADING

8.1 General Site Grading

Topsoil, man-made fill, and soils loosened by construction activities should be removed (stripped) from the building, pavement, and concrete flatwork areas prior to foundation excavation and placement of site grading fills. Following stripping and any additional excavation required to achieve design grades, the subgrade should be proof rolled to a firm, non-yielding surface. Soft areas detected during the proof-rolling operation, should be removed and replaced with structural fill.

8.2 Structural Fill and Compaction

All fill placed below the building, pavements, and concrete flatwork should be structural fill. All other fills should be considered as backfill. Structural fill should consist of native gravels or an imported material. Imported material should consist of well-graded sandy gravels with a maximum particle size of 3 inches and 5 to 15 percent fines (materials passing the No. 200 sieve). The liquid limit of the fines should not exceed 35 and the plasticity index should be below 15. All fill soils should be free from topsoils, highly organic material, frozen soil, and other deleterious materials. Structural fill should be placed in maximum 8-inch thick loose lifts at a moisture content within 2 percent of optimum and compacted to at least 95 percent of maximum density (ASTM D 1557) under the building and 90 percent under pavements and concrete flatwork.

8.3 Backfill

The native soils may be used as backfill in utility trenches and against the outside foundation walls where these areas are not below structures, pavements, or flatwork concrete. Backfill should be placed in lift heights suitable to the compaction equipment used and compacted to at least 90 percent of the maximum dry density (ASTM D 1557).

8.4 Excavations

Temporary construction excavations at the site which are less than five feet deep should have slopes no steeper than ½ to1 (horizontal to vertical). All excavations which are advanced deeper than five feet below site grades should be sloped or braced in accordance with OSHA[1] Health and Safety Standards for type C soils.

9.0 GEOLOGICAL HAZARDS

Geological hazards at this site are addressed in a report prepared by Western Geologic. The geologic report is presented in the appendix at the end of this report. This report indicates that a large debris flow event in Sardine Canyon could cause shallow flooding and debris deposition at the site. Although possible, the risk of this event occurring is low. If it is desired to mitigate this risk, site grads should be raised several feet.

---

1 Occupational Safety and Health Administration, "Occupational Safety and Health Standards - Excavations" Final Rule, 29 CFR part 1926.

10.0 SEISMIC CONSIDERATIONS

10.1 Seismic Design Criteria

The structure should be designed in accordance with IBC building codes. According to Section 1615.1.2 of the IBC, this site is classified as Site Class D.

10.2 Liquefaction

Liquefaction is a phenomenon where soils lose their intergranular strength due to an increase of pore pressures during a dynamic event such as an earthquake. The potential for liquefaction is based on several factors, including 1) the grain size distribution of the soil, 2) the plasticity of the fine fraction of the soil (material passing the No. 200 sieve), 3) relative density of the soil, 4) earthquake strength (magnitude) and duration, and 5) overburden pressures. In addition, the soils must be near saturation for liquefaction to occur. According to the Utah Geologic Survey liquefaction map[2], this site is in an area classified as having a very low potential for liquefaction.

11.0 FOUNDATIONS

11.1 Footing Design

The native soils at this site are capable of supporting the proposed structure if the recommendations presented in this report are followed. The recommendations presented below should be utilized during design and construction of this project:

---

2 Utah Geologic Survey, Selected Critical Facilities and Geologic Hazards, Weber County, Utah

1. Spread footings founded on undisturbed native soils or structural fill should be designed for a maximum allowable soil bearing capacity of 2500 psf. A one-third increase is allowed for short term transient loads such as wind and seismic events. Footings should be uniformly loaded.

2. Spread footings should have minimum widths of 20 and 36 inches for walls and columns, respectively.

3. Exterior footings should be placed below frost depth which is determined by local building codes. Generally 30 inches is adequate in this area. Interior footings, not subject to frost, should extend at least 18 inches below the lowest adjacent grade.

4. Foundation walls on continuous footings should be well reinforced both top and bottom. We suggest a minimum amount of steel equivalent to that required for a simply supported span of 12 feet.

5. Prior to placement of fill, the bottom of footing excavations should be compacted with a non-vibratory compactor to densify soils loosened during excavation and to identify soft spots. If soft areas are encountered, they should be removed and replaced as recommended in Section 8.1.

6. Footing excavations should be observed by the geotechnical engineer prior to placement of structural fill and construction of footings to evaluate whether suitable bearing soils have been exposed and verify that excavation bottoms are free of loose or disturbed soils.

11.2 Estimated Settlement

If footings are designed and constructed in accordance with the recommendations presented above, the risk of total settlement exceeding 1 inch and differential settlement exceeding 0.5 inch for a 25-foot span will be low. Additional settlement should be expected during a strong seismic event.

11.3 Lateral Resistance

Lateral building loads will be resisted by frictional resistance between the footings and the foundation soils and by passive pressure developed by backfill against the wall. For footings on native soils we recommend a friction coefficient of 0.33 be used. Passive pressures may be calculated using an equivalent fluid density of 425 pcf. The lateral earth coefficients presented above are ultimate values; therefore, an appropriate factor of safety should be applied to these values.

12.0 FLOOR SLABS

The native soils below floor slabs should be proof rolled and a minimum 4 inch thick layer of free-draining gravel should be placed immediately below the floor slab to help distribute floor loads, break the rise of capillary water, and aid in the concrete curing process. For slab design, we recommend a modulus of subgrade reaction of 400 psi/in be used. To help control normal shrinkage and stress cracking, the floor slabs should have adequate reinforcement for the anticipated floor loads with the reinforcement continuous through interior floor joints. In addition we recommend utilizing frequent crack control joints.

Special precautions should be taken during placement and curing of concrete. Excessive slump (high water-cement ratios) of the concrete and/or improper finishing and curing procedures used during hot or cold weather conditions may lead to excessive shrinkage, cracking, spalling, or curling of the foundation walls and slabs. We recommend all concrete placement and curing operations be performed in accordance with American Concrete Institute (ACI) codes and practices.

13.0 SURFACE DRAINAGE

Wetting of the foundation soils will likely cause some degree of volume change within the soil and should be prevented both during and after construction. We recommend that the following precautions be taken at this site:

1. The ground surface should be graded to drain away from the structure in all directions. We recommend a minimum fall of 8 inches in the first 10 feet in landscaped areas and 4 inches in the first 10 feet in paved areas.

2. Roof runoff should be collected in roof drains or rain gutters with down spouts designed to discharge well outside of the backfill limits.

3. Sprinkler heads, if planned, should be aimed away and kept at least 12 inches from foundation walls.

4. Provide adequate compaction of foundation backfill i.e. a minimum of 90% of ASTM D 1557. Water consolidation methods should not be used.

5. Other precautions which may become evident during design and construction should be taken.

14.0 PAVEMENTS

We understand that flexible pavements are desired for the roads in this development. Unless a more stringent local code is required, we recommend a pavement section consisting of 3.5 inches of asphaltic concrete over 8 inches of untreated aggregated base. The design recommendations were based on an assumed CBR value of 20%, AASHTO design methods and the following assumptions:

1. The subgrade is proof rolled to a firm non-yielding condition and soft areas are removed and replaced, as discussed in Section 8.1;

2. Grading fills below the pavements meet imported structural fill material and placement requirements as defined in Section 8.2 of this report;

3. Aggregate base meets UDOT specification requirements;

4. Aggregate base is compacted to at least 95 percent of maximum dry density (ASTM D 1557);

5. Asphaltic concrete is compacted to at least 96 percent of the laboratory Marshal mix design density (ASTM D 1559);

6. Traffic loads are as discussed in Section 3.0; and

7. Pavement design life of 20 years.

15.0 PERCOLATION TEST

To assist in designing a septic system for the proposed project, two percolation tests were performed at different elevations within test pit TP-3 (the proposed site of the septic system). The tests produced a percolation rates of 2.7 min/inch for the top 30 inches of soil and 0.4 min/inch for the material below 30 inches . The percolation test certificates may be found in the attached appendix.

16.0 GENERAL CONDITIONS

The exploratory data presented in this report were collected to provide geotechnical design recommendations for this project. Test pits were widely spaced and may not be indicative of subsurface conditions between the test pits or outside the study area and thus have limited value in depicting subsurface conditions for contractor bidding. If it is necessary to define subsurface conditions in sufficient detail to allow accurate bidding we recommend an additional study be conducted which is designed for that purpose.

Variations from the conditions portrayed in the test pits often occur which are sometimes sufficient to require modifications in the design. If during construction, conditions are found to be different than those presented in this report, please advise us so that the appropriate modifications can be made. An experienced geotechnical engineer or technician should observe fill placement and conduct testing as required to confirm the use of proper structural fill materials and placement procedures.

The geotechnical study as presented in this report was conducted within the limits prescribed by our client, with the usual thoroughness and competence of the engineering profession in the area. No other warranty or representation, either expressed or implied, is intended in our proposals, contracts or reports.

We appreciate the opportunity of providing our services on this project. If we can answer questions or be of further service, please call.

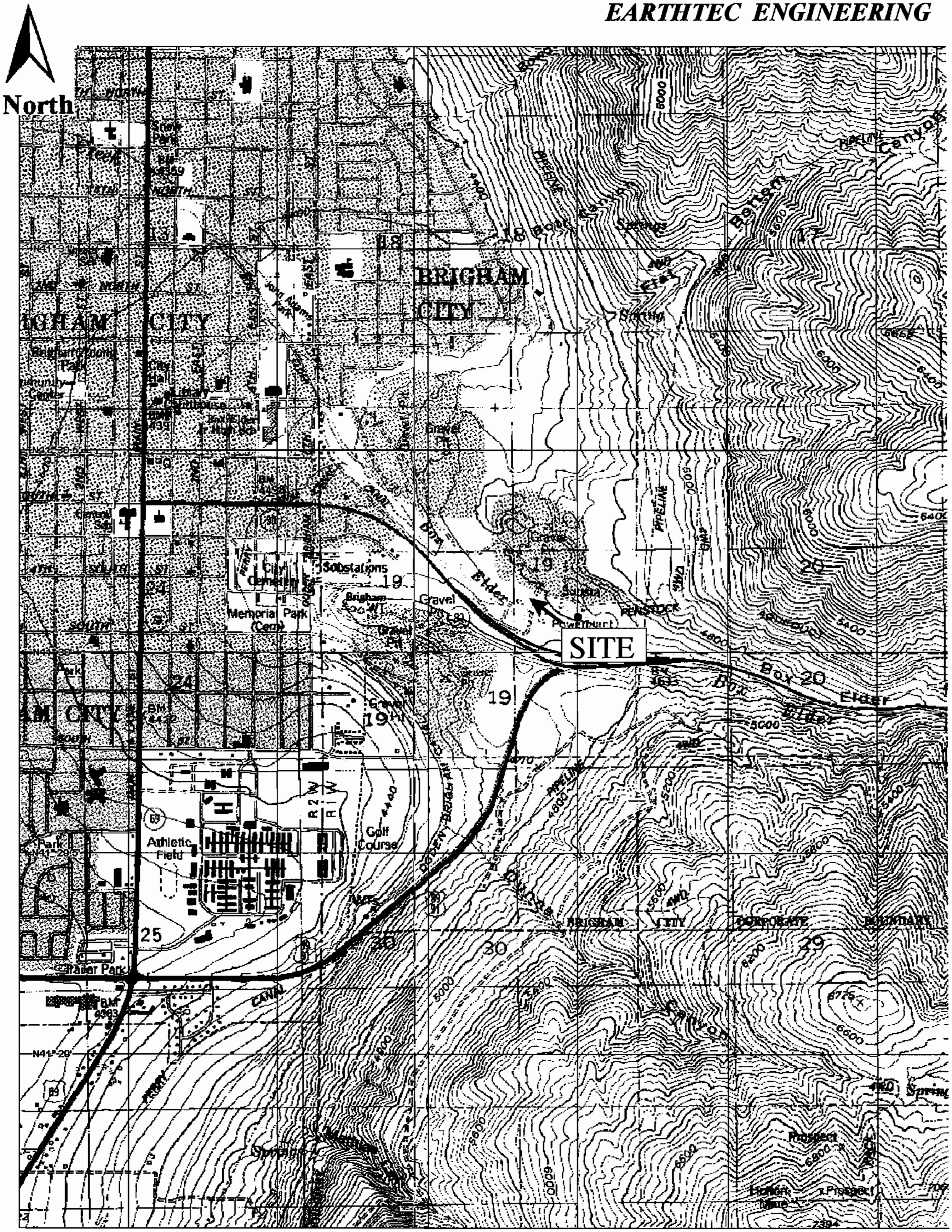
Respectfully;
EARTHTEC ENGINEERING, P.C.

Mark I. Christensen, P.E.
Project Geotechnical Engineer

3 copies sent

REV:REB

EARTHTEC ENGINEERING



700 ft Scale: 1 : 24,000 Detail: 13-0 Datum: WGS84

ETE Job No. 05-2530 **VICINITY MAP** **Figure 1**

TEST PIT LOG
NO.: TP-1

PROJECT: UDOT Building
CLIENT: JUB Engineers
LOCATION: See Figure 2
OPERATOR: K R Dickamore General Engineering
EQUIPMENT: Backhoe
DEPTH TO WATER; INITIAL ▽:

PROJECT NO.: 05-2530
DATE: 10/10/05
ELEVATION: Not Measured
LOGGED BY: Mark Christensen
AT COMPLETION ▼:

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Dry Dens. (pcf)	Water Cont. (%)	PI	LL	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0–1.5		FILL	Fill; Silty Gravel with sand - moist, brown									
1.5–8		GP	Poorly Graded Gravel with sand - medium dense, moist, light brown									
4–5				X		2			51.5	46.8	1.7	
8–10												

Notes: No groundwater encountered.

Tests Key
- CBR = California Bearing Ratio
- C = Consolidation
- R = Resistivity
- DS = Direct Shear
- SS = Soluble Sulfates
- UC = Unconfined Compressive Strength

PROJECT NO.: 05-2530 — Earthtec Testing and Engineering, P.C. — **FIGURE NO.:** 2

TEST PIT LOG

NO.: TP-2

PROJECT:	UDOT Building	**PROJECT NO.:**	05-2530
CLIENT:	JUB Engineers	**DATE:**	10/10/05
LOCATION:	See Figure 2	**ELEVATION:**	Not Measured
OPERATOR:	K R Dickamore General Engineering	**LOGGED BY:**	Mark Christensen
EQUIPMENT:	Backhoe		
DEPTH TO WATER; INITIAL ∇:		**AT COMPLETION ▼:**	

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Dry Dens. (pcf)	Water Cont. (%)	PI	LL	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0–7.5		GP	Poorly Graded Gravel with sand - medium dense, moist, light brown - brown below 5 1/2 feet	X (6–7)								
7.5–10												

TEST RESULTS (Dry Dens., Water Cont., PI, LL, Gravel, Sand, Fines, Other Tests)

Notes: No groundwater encountered.

Tests Key
- CBR = California Bearing Ratio
- C = Consolidation
- R = Resistivity
- DS = Direct Shear
- SS = Soluble Sulfates
- UC = Unconfined Compressive Strength

TEST PIT LOG

NO.: TP-3

PROJECT:	UDOT Building	**PROJECT NO.:**	05-2530
CLIENT:	JUB Engineers	**DATE:**	10/10/05
LOCATION:	See Figure 2	**ELEVATION:**	Not Measured
OPERATOR:	K R Dickamore General Engineering	**LOGGED BY:**	Mark Christensen
EQUIPMENT:	Backhoe		
DEPTH TO WATER; INITIAL ▽:		**AT COMPLETION ▼:**	

Depth (Ft.)	Graphic Log	USCS	Description	Samples	TEST RESULTS Dry Dens. (pcf)	Water Cont. (%)	PI	LL	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0–1		FILL	Fill, Silty Gravel with sand - moist, brown									
1–10		GP	Poorly Graded Gravel with sand - medium dense, moist, brown									

Notes: No groundwater encountered.

Tests Key
- CBR = California Bearing Ratio
- C = Consolidation
- R = Resistivity
- DS = Direct Shear
- SS = Soluble Sulfates
- UC = Unconfined Compressive Strength

PROJECT NO.: 05-2530 | Earthtec Testing and Engineering, P.C. | **FIGURE NO.:** 4

LOG OF TESTPIT 05-2530.GPJ EARTHTEC.GDT 10/27/05

LEGEND

PROJECT: UDOT Building **DATE:**
CLIENT: JUB Engineers **LOGGED BY:**

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR SOIL DIVISIONS			USCS SYMBOL	TYPICAL SOIL DESCRIPTIONS
COARSE GRAINED SOILS (More than 50% retaining on No. 200 Sieve)	GRAVELS (More than 50% of coarse fraction retained on No. 4 Sieve)	CLEAN GRAVELS (Less than 5% fines)	GW	Well Graded Gravel, May Contain Sand, Very Little Fines
			GP	Poorly Graded Gravel, May Contain Sand, Very Little Fines
		GRAVELS WITH FINES (More than 12% fines)	GM	Silty Gravel, May Contain Sand
			GC	Clayey Gravel, May Contain Sand
	SANDS (50% or more of coarse fraction passes No. 4 Sieve)	CLEAN SANDS (Less than 5% fines)	SW	Well Graded Sand, May Contain Gravel, Very Little Fines
			SP	Poorly Graded Sand, May Contain Gravel, Very Little Fines
		SANDS WITH FINES (More than 12% fines)	SM	Silty Sand, May Contain Gravel
			SC	Clayey Sand, May Contain Gravel
FINE GRAINED SOILS (More than 50% passing No. 200 Sieve)	SILTS AND CLAYS (Liquid Limit less than 50)		CL	Lean Clay, Inorganic, May Contain Gravel and/or Sand
			ML	Silt, Inorganic, May Contain Gravel and/or Sand
			OL	Organic Silt or Clay, May Contain Gravel and/or Sand
	SILTS AND CLAYS (Liquid Limit Greater than 50)		CH	Fat Clay, Inorganic, May Contain Gravel and/or Sand
			MH	Elastic Silt, Inorganic, May Contain Gravel and/or Sand
			OH	Organic Clay or Silt, May Contain Gravel and/or Sand
HIGHLY ORGANIC SOILS			PT	Peat, Primarily Organic Matter

SAMPLER DESCRIPTIONS

- SPLIT SPOON SAMPLER (1 3/8 inch inside diameter)
- MODIFIED CALIFORNIA SAMPLER (2½ inch outside diameter)
- SHELBY TUBE (3 inch outside diameter)
- BLOCK SAMPLE
- BAG/BULK SAMPLE

WATER SYMBOLS

- ▽ Water level encountered during field exploration
- ▼ Water level encountered at completion of field exploration

NOTES:
1. The logs are subject to the limitations, conclusions, and recommendations in this report.
2. Results of tests conducted on samples recovered are reported on the logs and any applicable graphs.
3. Strata lines on the logs represent approximate boundaries only. Actual transitions may be gradual.
4. In general, USCS symbols shown on the logs are based on visual methods only: actual designations (based on laboratory tests) may vary.

APPENDIX

PERCOLATION TEST CERTIFICATE
AND SOIL EXPLORATION RESULTS

Name: BRIGHAM CITY UDOT BUILDING

Location of Property: Brigham City, Utah

I certify that percolation tests have been conducted on the above property, in accordance with the requirements specified in R317-4-5.4 of the Utah Administrative Code, and that percolation rates, calculated as specified by said rule, are as follows:

Test Hole Number	Test Hole Depth (in)	Saturation Period (hrs & min)	Swelling Period (hrs & min)	Inches of Drop Final 1 min.	Final Stabilized Perc. Rate (min/inch)
TP-1 @ 26"	12"	20 min.	20 min.	3/8"	2.667 min/inch

Date Percolation Tests were completed: Oct. 20, 2005

Statement of soil conditions obtained from soil explorations to appropriate depths:

0" to 30"	Loamy Sand, Massive, 50% Gravel, Yellow Brown
30" to 78"	Sand, Single Grained, 50% Gravel, Tan

Statement of present and maximum anticipated ground water table:
No groundwater nor evidence of past groundwater was observed to the depth explored (78")

I hereby certify to the best of my knowledge, the foregoing information is correct.

Name: Bruce Nielsen
Wastewater Systems Program Cert. # 0467-2004-0T1

Address: 1596 W. 2650 S., #108
Ogden, UT 84404

Signed Bruce G. Nielsen Date: 10-27-05

ETE Job No. 05-2530

PERCOLATION TEST CERTIFICATE
AND SOIL EXPLORATION RESULTS

Name: BRIGHAM CITY UDOT BUILDING

Location of Property: Brigham City, Utah

I certify that percolation tests have been conducted on the above property, in accordance with the requirements specified in R317-4-5.4 of the Utah Administrative Code, and that percolation rates, calculated as specified by said rule, are as follows:

Test Hole Number	Test Hole Depth (in)	Saturation Period (hrs & min)	Swelling Period (hrs & min)	Inches of Drop Final 2.366 min.	Final Stabilized Perc. Rate (min/inch)
TP-1 @ 78"	12"	20 min.	20 min.	5 ¾"	0.41 min/inch

Date Percolation Tests were completed: Oct. 20, 2005

Statement of soil conditions obtained from soil explorations to appropriate depths:

0" to 30" Loamy Sand, Massive, 50% Gravel, Yellow Brown
30" to 78" Sand, Single Grained, 50% Gravel, Tan

Statement of present and maximum anticipated ground water table:
No groundwater nor evidence of past groundwater was observed to the depth explored (78")

I hereby certify to the best of my knowledge, the foregoing information is correct.

Name: Bruce Nielsen
Wastewater Systems Program Cert. # 0467-2004-0T1

Address: 1596 W. 2650 S., #108
Ogden, UT 84404

Signed *Bruce G. Nl* Date: *10-27-05*

ETE Job No. 05-2530

WESTERN GEOLOGIC, LLC
74 N STREET
SALT LAKE CITY, UTAH 84103 USA

Phone: 801.359.7222 Fax: 801.359.2730 Email: craig_nelson@western-geologic.com

October 13, 2005

Mr. Mark I. Christensen, P.E.
Earthtec Testing and Engineering, P.C.
1596 West 2650 South
Suite 108
Ogden, Utah 84401

SUBJECT: Geologic Hazards Reconnaissance
UDOT – Brigham City Site
Brigham City, Box Elder County, Utah

Dear Mr. Christensen:

This report presents results of a reconnaissance-level engineering geology and geologic hazards review and evaluation conducted by Western GeoLogic, LLC (Western GeoLogic) for a proposed UDOT maintenance and office building located at approximately 1325 East 200 South in Brigham City, Box Elder County, Utah (Figure 1 – Project Location). The site is on generally west-facing slopes at the base of the Wasatch Range, in the SW ¼ Section 19, Township 9 North, Range 1 West (Salt Lake Base Line and Meridian). Elevation of the site is about 4,570 feet above sea level.

PURPOSE AND SCOPE

The purpose of the investigation was to identify and interpret surficial geologic conditions at the site and to evaluate any potential geologic hazards to the project. The following services were performed in accordance with that purpose:

- A site reconnaissance conducted by an experienced certified engineering geologist to assess the site setting and look for evidence of adverse geologic conditions,
- Excavation and logging of three test pits,
- Review of available geologic maps and reports, and
- Evaluation of available data and preparation of this report, which presents the results of our study.

The engineering geology section of this report was prepared in general accordance with the Guidelines for Preparing Engineering Geologic reports in Utah (Utah Section of the Association of Engineering Geologists, 1986).

SITE RECONNAISSANCE

On October 10, 2005 Mr. Bill D. Black of Western GeoLogic conducted a site reconnaissance of the property and surrounding area. Weather at the time of the initial site reconnaissance was sunny, with temperatures in the 70's (°F). The site is on the edge of a gravel pit excavation and most native vegetation has been removed; vegetation in adjacent areas generally consists of grasses, sage brush, and scattered cedar and box elder trees. Most of the property is currently developed, consisting of an existing light industrial building in the southern half of the site surrounded by paved parking. Slopes at the site dip gently to the west at an overall gradient of about 15:1 (horizontal:vertical).

Digital orthophoto aerial photography (National Aerial Photography Program, frame NAPP 5922 027; September, 1993) was reviewed to obtain information about the geomorphology of the site and surrounding area (Figure 2). The site is at the base of the Wasatch Range in the floodplain of Box Elder Creek, about 2,500 feet west of the mouth of Sardine Canyon (Figures 1 and 2). Several east- and west-dipping traces of the Wasatch fault zone are evident about 750 feet to the northeast and form a roughly 1,000-foot wide fault zone (Figure 2). Box Elder Creek flows to the northwest along the southern edge of the property into a retaining pond about 600 feet west of the site, and then continues to the northwest below the retaining pond (Figure 2). The site is below the Provo and Bonneville shorelines of Lake Bonneville (labeled P and B, respectively; Figure 2), which form prominent escarpments about 0.4 miles southeast of the site. Numerous terrace escarpments are evident in the site vicinity from downcutting by the creek through older alluvium and deltaic deposits from Pleistocene Lake Bonneville (dark toothed lines, Figure 2). No other geologic hazards are evident on the photo or were observed at the site.

Three test pits were excavated at the site to evaluate subsurface conditions (Figure 3). All three test pits exposed a similar sequence of stream alluvium comprised of gravelly sand to sandy gravel (Figure 3). Bedding in the alluvium appeared to dip about 15° to the west. Test pits 1 and 3 (Figure 3) also exposed fill at the surface from prior grading and excavation activity. No water was evident in the test pits, and the exposed sediments appeared very dry.

HYDROLOGY

The U.S. Geological Survey (USGS) topographic map of the Mount Pisgah Quadrangle shows Box Elder Creeks flows northwestward along the southern site boundary. No surface-water impoundments are at the property, but a retaining pond fed by the creek is about 600 feet west of the site. No springs, seeps, or marshes were observed at the site. At the time of the field reconnaissance, surficial soils at the site appeared dry.

The subsurface hydrology in the area is dominated by the East Shore aquifer system. This aquifer system is comprised of a shallow, unconfined water table zone, and the deeper, often confined, Sunset and Delta aquifers (Feth and others, 1966). The depth to the shallow unconfined aquifer varies somewhat depending on topography and climatic and seasonal fluctuations. It is influenced by seepage from irrigation systems, infiltration from precipitation and urban runoff, and upward leakage from the confined aquifer in places. The Sunset aquifer (typical depth 250-400 feet) and Delta aquifer (typical depth 500-700 feet) provide water that generally meets the standards for public drinking water supply (Clark and others, 1990). Based on topography, regional groundwater flow is expected to be to the southwest.

Elevation of the shallow aquifer varies somewhat based on seasonal and climatic fluctuations. No ground water was observed in the test pits to a depth of 10 feet, and exposed sediments appeared dry and well drained. Depth to ground water is likely between 10 and 30 feet at the site given its location adjacent to Box Elder Creek.

GEOLOGY

Seismotectonic Setting

The property is located west of the base of the Wasatch Range. The Wasatch Range is a major north-south trending mountain range marking the eastern boundary of the Basin and Range physiographic province (Stokes, 1977, 1986). The Basin and Range province is characterized by a series of generally north-trending elongate mountain ranges, separated by predominately alluvial and lacustrine sediment-filled valleys and typically bounded on one or both sides by major normal faults (Stewart, 1978). The boundary between the Basin and Range and Middle Rocky Mountains provinces is the prominent, west-facing escarpment along the Wasatch fault zone at the base of the Wasatch Range. Late Cenozoic normal faulting, a characteristic of the Basin and Range, began between about 17 and 10 million years ago in the Nevada (Stewart, 1980) and Utah (Anderson, 1989) portions of the province. The faulting is a result of a roughly east-west directed, regional extensional stress regime that has continued to the present (Zoback and Zoback, 1989; Zoback, 1989). A roughly 1,000-foot-wide complex fault zone comprised of numerous east- and west-dipping fault traces associated with the Brigham City section of the Wasatch fault zone is about 750 feet northeast of the site.

The site is also in the central portion of the Intermountain Seismic Belt (ISB), a generally north-south trending zone of historical seismicity along the eastern margin of the Basin and Range province extending from northern Arizona to northwestern Montana (Sbar and others, 1972; Smith and Sbar, 1974). At least 16 earthquakes of magnitude 6.0 or greater have occurred within the ISB since 1850; the largest of these earthquakes was a M_S 7.5 event in 1959 near Hebgen Lake, Montana. However, none of these earthquakes occurred along the Wasatch fault or other known late Quaternary faults (Arabasz and others, 1992; Smith and Arabasz, 1991). The closest of these events was the 1934 Hansel Valley (M_S 6.6) event north of the Great Salt Lake.

The Wasatch fault zone is one of the longest and most active normal-slip faults in the world, and extends for 213 miles along the western base of the Wasatch Range from southeastern Idaho to north-central Utah (Machette and others, 1992). The fault zone generally trends north-south and, at the surface, can form a zone of deformation up to several hundred feet wide containing many subparallel west-dipping main faults and east-dipping antithetic faults. Previous studies divided the fault zone into 10 segments, each of which rupture independently and are capable of generating large-magnitude surface-faulting earthquakes (Machette and others, 1992). The central five segments of the fault (Brigham City, Weber, Salt Lake, Provo, and Nephi) have each produced two or more surface-faulting earthquakes in the past 6,000 years (Black and others, 2003).

The Brigham City section extends for about 23 miles from the southern edge of the Plain View salient near North Ogden to Jim May Canyon northeast of Honeyville (Machette and others, 1992). Paleoseismic data indicate the most recent event on the Brigham City section occurred around 2,100 years ago (Black and others, 2003), with a preferred recurrence interval (time between earthquakes) of 2,100 years (Lund, 2005).

Unconsolidated Deposits

The site is located within the Wasatch Front Valley System, a deep sediment-filled, structural basin flanked by uplifted mountain range blocks. The site is located below both the Provo and Bonneville shorelines of Lake Bonneville. Surficial geology at the site was mapped by Personius (1990) as Holocene to uppermost Pleistocene stream alluvium (units al1 and al2, Figure 2). Personius (1990) describes surficial units in the vicinity of the site (Figure 2) as follows:

> ***al1 - Stream alluvium (upper Holocene).*** Clast-supported pebble and cobble gravel, in a matrix of sand, silt, and minor clay; contains thin sand lenses; moderately sorted; clasts subangular to rounded; thin to medium bedded. Deposited by perennial streams (Box Elder, Threemile, and Willard Creeks) on the modern flood plain and in low terraces less than 5 m above modern stream level. May include minor sheetwash and slump deposits overlying alluvium along steep stream embankments. Deposits along Box Elder, Threemile, and Willard Creeks grade downslope into large Holocene alluvial fans (af1, afy). Exposed thickness <5 m.

> ***al2 - Stream alluvium (middle Holocene to uppermost Pleistocene).*** Clast-supported pebble and cobble gravel, in a matrix of sand, silt, and minor clay; contains thin sand lenses; moderately sorted; clasts subangular to rounded; thin to medium bedded. Deposited by perennial streams (Box Elder Creek and Ogden River); forms terraces more than 5 m above modern stream level, usually inset into Bonneville-lake-cycle lacustrine gravels. Grades downslope into large alluvial fan (af1) at the mouth of Box Elder Canyon. Exposed thickness <5 m.

alp - Stream alluvium (uppermost Pleistocene). Clast-supported pebble and cobble gravel, in a matrix of sand, silt, and minor clay; contains thin sand lenses; poor to moderately sorted, clasts subangular to rounded; thin to medium bedded. Deposited as topset beds on Provo-shoreline-equivalent deltaic deposits (lpd) at the mouths of Box Elder, Perry (Threemile), and Willard Canyons. Shorelines may be preserved on the surfaces of alp deposits. Exposed thickness <5 m.

af1 - Fan alluvium (upper Holocene). Clast-supported pebble and cobble gravel, locally bouldery, in a matrix of sand, silt, and minor clay; poorly sorted; clasts angular to subrounded, with very rare well= rounded, recycled Bonneville-lake-cycle gravel clasts; medium to thick bedded to massive. Deposited by intermittent streams, debris flows, and debris floods graded to modem stream level; forms small discrete fans on the surface of larger fans of unit af2 north of Willard, and large fans that bury deposits of unit af2 elsewhere in map area. May contain small deposits of units cdl and af2. No lacustrine shorelines occur on surfaces. Locally grades downslope into unit lbpm. Typical soil profiles range from A-Cn to A-Bw-Cox-Cn. Exposed thickness < 5m.

af2 - Fan alluvium (middle Holocene to uppermost Pleistocene). Clast-supported pebble and cobble gravel, locally bouldery and matrix supported, in a matrix of sand, silt, and minor clay; poorly sorted clasts angular to subrounded, with rare well-rounded, recycled Bonneville-lake-cycle gravel clasts; medium to thick bedded to massive. Deposited by perennial and intermittent streams, debris flows, and debris floods, graded approximately to modern stream level; forms large fans inset into the Provo shoreline at the mouths of major canyons along the mountain front; fans at Perry (Threemile) and Box Elder Canyons contain much higher proportion (20-70 percent) of recycled lacustrine gravels, and probably represent post-Provo- shoreline fan deltas graded to about modem lake level. Also preserved downslope from distal portions of large fans of unit af1. No lacustrine shorelines occur on the surfaces. May contain small deposits of units af1 and cdl, and usually grades downslope into unit lbpm. Typical soil profiles range from A-Bw-Cox-Cn to A-Bt(v. weak)-Cox-Cn. Exposed thickness < 10 m.

afp - Fan alluvium related to Provo shoreline (uppermost Pleistocene). Clast-supported pebble and cobble gravel, locally bouldery, in a matrix of sand, silt, and minor clay; poor to moderately sorted; clasts angular to well rounded, usually with 10-50 percent well rounded recycled Bonneville-lake-cycle gravel clasts; medium to thick bedded to massive. Deposited by streams associated with the Provo stillstand; forms fans graded to the Provo shoreline, or graded from the Provo shoreline to phantom lake levels above the modern flood plain; may in part be stream-reworked deltaic or fan-delta deposits. Regressional shorelines may be preserved on the surfaces of fans graded from the Provo shoreline. Preserved mostly as remnants; units af1 and af2 inset into afp deposits. Typical soil profiles range from A-Bw-Cox-Cn to A-Bt(v. weak)-Cox-Cn. Exposed thickness < 10 m.

cls - Landslide deposits (Holocene to middle Pleistocene). Unsorted, unstratified deposits ranging in size from sand and silt to boulder-rich gravels and bedrock blocks; usually deposited as slides and slump-earthflows on relatively steep slopes. Large slide east of Brigham City probably has undergone multiple movements; latest movement on lower portion of the slide postdates deposition of the Provo-shoreline-equivalent delta (lpd) at the mouth of Box Elder Canyon. Small slump blocks along the main fault scarp east of Brigham City appear to be a result of oversteepened slopes and springs along fault zone. Large slide near Facer Creek composed of displaced bedrock from Facer and Perry Canyon Formations; large areas of landslide deposits underlain by these formations in mountains northeast of Willard attest to the susceptibility of these metamorphic rocks to movement. The Facer Creek slide has undergone several movements, both before and after Bonneville Lake-cycle deposition; although both the Provo and Bonneville shorelines are distorted, they can be traced with difficulty through the Facer Creek slide. Fault scarps are difficult to trace through cls deposits. Exposed thickness varies.

lpd - Deltaic deposits related to Provo shoreline (uppermost Pleistocene). Clast-supported pebble and cobble gravel, in a matrix of sand and minor silt; interbedded with thin sand beds; moderate to well sorted within beds; clasts subround to round, with weak carbonate cementation common; deposited as foreset beds with original dips of 30° to 35°. Commonly capped with < 5 m thick topset beds of less well sorted, silty to sandy, pebble and cobble alluvial gravel (alp). Mapped at the mouths of Box Elder, Perry (Threemile), and Willard Canyons; other deltaic deposits that existed in the map area have been reworked by subsequent stream action. Exposed thickness <20 m.

lpg - Lacustrine sands and gravels related to Provo shorelines (uppermost Pleistocene). Clast-supported pebble and cobble gravel, in a matrix of sand and silt; commonly interbedded (sometimes rhythmically) with thin sand beds; good sorting within beds; clasts subround to round; may be carbonate cemented, especially along shorelines; thin to thick bedded; bedding ranges from horizontal to original dips of as much as 10° to 15°. Deposited in beaches, bars, spits, as well as deltas that no longer retain distinctive morphology; mapped at Provo shoreline (1,470-1,475 m (4,820-4,840 ft) in map area), and below; grades downslope into deposits of unit lbpg; contact with unit lbpg is mapped where deposits can no longer be correlated with Provo-shoreline-equivalent deltaic deposits or regressional shorelines. Exposed thickness <5 m.

Lake Bonneville History

Lakes occupied nearly 100 basins in the western United States during late-Quaternary time, the largest of which was Lake Bonneville in northwestern Utah. The Bonneville basin consists of several topographically closed basins created by regional extension in the Basin and Range (Gwynn, 1980; Miller, 1990), and has been an area of internal drainage for much of the past 15 million years. Lake Bonneville consisted of numerous topographically closed basins, including the Salt Lake and Cache Valleys (Oviatt and others, 1992). Sediments from Lake Bonneville comprise some of the unconsolidated deposits in the site vicinity.

Approximately 30,000 years ago, Lake Bonneville began a slow transgression (rise) to its highest level of 5,160 to 5,200 feet above mean sea level. The lake rise eventually slowed as water levels approached an external basin threshold in northern Cache Valley at Red Rock Pass near Zenda, Idaho. Lake Bonneville reached the Red Rock Pass threshold and occupied its highest shoreline, named the Bonneville beach, after 16,000 years ago. The lake remained at this level until 14,500 years ago, when headward erosion of the Snake River-Bonneville basin drainage divide caused a catastrophic incision of the threshold and the lake level lowered by roughly 360 feet in fewer than two months (Jarrett and Malde, 1987; O'Conner, 1993). Following the Bonneville flood, the lake stabilized and formed a lower shoreline referred to as the Provo shoreline. Climatic factors then caused the lake to regress rapidly from the Provo shoreline, and by about 11,000 years ago the lake had eventually dropped below the present elevation of Great Salt Lake. Oviatt and others (1992) deem this low stage the end of the Bonneville lake cycle. The site is below both the Bonneville and Provo shorelines.

GEOLOGIC HAZARDS

Assessment of potential geologic hazards and the resulting risks imposed is critical in determining the suitability of the site for development. A discussion and analysis of geologic hazards follows.

Earthquake Ground Shaking

Ground shaking refers to the ground surface acceleration caused by seismic waves generated during an earthquake. Strong ground motion is likely to present a significant risk during moderate to large earthquakes located within a 60 mile radius of the project area (Boore and others, 1993). Seismic sources include mapped active faults, as well as a random or "floating" earthquake source on faults not evident at the surface. Mapped active faults within this distance include: the East and West Cache fault zones; the Brigham City, Weber, Salt Lake, and Provo segments of the Wasatch fault zone; the East Great Salt Lake fault zone; the Morgan Fault; the West Valley fault zone; the Oquirrh fault zone; and the Bear River fault zone (Black and others, 2003).

The extent of property damage and loss of life due to ground shaking depends on factors such as: (1) proximity of the earthquake and strength of seismic waves at the surface (horizontal motions are the most damaging); (2) amplitude, duration, and frequency of ground motions; (3) nature of foundation materials; and (4) building design. Peak accelerations (% of gravity) at the site for 10% and 2% probabilities of exceedance in 50 years are estimated at 21 %g, and 60 %g respectively (Frankel and others, 2002). Horizontal accelerations on the 10 percent in 50-year map were typically used in building design prior to 2003.
Given this information, earthquake ground shaking is a risk to the subject site. The

hazard from earthquake ground shaking can be adequately mitigated by design and construction of homes in accordance with appropriate building codes.

Surface Fault Rupture

Movement along faults at depth generates earthquakes. During earthquakes larger than Richter magnitude 6.5, ruptures along normal faults in the intermountain region generally propagate to the surface (Smith and Arabasz, 1991) as one side of the fault is uplifted and the other side down dropped. The resulting fault scarp has a near-vertical slope. The surface rupture may be expressed either as a large, singular scarp, or several smaller ruptures comprising a fault zone. Ground displacement from surface fault rupture can cause significant damage or even collapse to structures located across a rupture zone.

No faults are mapped at the site and no evidence for faulting was observed on air photos or in the field reconnaissance. Based on this, the hazard from surface faulting is low. The nearest mapped faults associated with the Brigham City section of the Wasatch fault zone are about 750 feet to the northeast.

Liquefaction and Lateral-spread Ground Failure

Liquefaction occurs when saturated, loose, cohesionless, soils lose their support capabilities during a seismic event because of the development of excessive pore pressure. Earthquake-induced liquefaction can present a significant risk to structures from bearing-capacity failures to structural footings and foundations, and can damage structures and roadway embankments by triggering lateral spread landslides. Earthquakes of Richter magnitude 5 are generally regarded as the lower threshold for liquefaction. Liquefaction potential at the site is a combination of expected seismic (earthquake ground shaking) accelerations, ground water conditions, and presence of susceptible soils.

No sediments were exposed in the test pits or are mapped as possibly underlying the site that are likely susceptible to liquefaction. Liquefaction potential is also dependant on ground-water depth, which is likely between 10 and 30 feet at the site. No evidence of groundwater was observed in the test pits, and sediments in the test pits also appeared undeformed and showed no evidence of liquefaction in the geologic past. Based on all of the above, the existing hazard from liquefaction at the site is rated as low.

Tectonic Deformation

Tectonic deformation refers to subsidence from warping, lowering, and tilting of a valley floor that accompanies surface-faulting earthquakes on normal faults. Large-scale tectonic subsidence may accompany earthquakes along large normal faults (Lund, 1990). Tectonic subsidence is believed to mainly impact those areas immediately adjacent to the downthrown side of a normal fault. The site is located about 750 feet west of and on the downthrown side of the Wasatch fault zone, and could experience a few degrees of tilting from a large-magnitude, surface-faulting earthquake on the Weber segment. However, tectonic subsidence is not typically a life-safety issue and does not pose a significant constraint to the proposed development.

Seismic Seiche and Storm Surge
Earthquake-induced seiche presents a risk to structures within the wave-oscillation zone along the edges of large bodies of water, such as the Great Salt Lake. Given the elevation of the subject property and distance from large bodies of water, the risk to the subject property from seismic seiches is rated as very low.

Stream Flooding
Stream flooding may be caused by direct precipitation, melting snow, or a combination of both. In much of Utah, floods are most common in April through June during spring snowmelt. High flows may be sustained from a few days to several weeks, and the potential for flooding depends on a variety of factors such as surface hydrology, site grading and drainage, and runoff. Box Elder Creek flows northwestward along the southern edge of the site, and the site is located in mapped stream alluvium deposits in the floodplain of the creek. Given the above, the site may have a potential hazard from stream flooding. Evaluation of site hydrology and runoff should be addressed by the civil engineering design for the development in conformance with Brigham City and Box Elder County development guidelines.

Shallow Groundwater
No springs are shown on the topographic map for the Mount Pisgah Quadrangle at the site and none were observed during the site reconnaissance. No evidence of ground water was found in the test pits, and depth to ground water is likely between 10 and 30 feet. Ground-water depth can fluctuate based on seasonal and climatic variations in up-gradient runoff infiltration, and may decrease as water is added from sources such as landscape irrigation. Local perched groundwater zones may be present above less-permeable sediments. However, shallow groundwater should not pose a significant constraint for the proposed development.

Landslide and Slope Failures
Slope stability hazards such as landslides, slumps, and other mass movements can develop along moderate to steep slopes where a slope has been disturbed, the head of a slope loaded, or where increased ground-water pore pressures result in driving forces within the slope exceeding restraining forces. Slopes exhibiting prior failures, and also deposits from large landslides, are particularly vulnerable to instability and reactivation.

The geologic map (Figure 2) shows no mass movement deposits at the site or in higher or lower slopes adjacent to the site. Given this information, the relatively gentle dip of slopes at the site, and evidence of undeformed sediments in the test pits, existing slopes at the site appear stable and the risk from slope failures is low. Recommendations regarding slope stability, grading, and site drainage should be addressed in a geotechnical engineering evaluation during the subdivision approval process.

Debris Flows

Debris flow hazards are typically associated with unconsolidated alluvial fan deposits at the mouths of large range-front drainages, such as those along the Wasatch Front. No evidence of debris flow channels, levees, or other debris flow features was observed at the site during the field reconnaissance, and the site is not located in mapped debris flow or alluvial fan deposits. The site appears to be in a zone of transport and erosion locally modified by gravel excavation, with alluvial-fan deposition occurring further westward. Given this information and the distance of the site from the canyon mouth (about 2,500 feet), the hazard from debris flows at the site should be low. However, a large debris-flow event in Sardine Canyon that overtops the creek banks could cause shallow flooding and debris deposition at the site.

Rock Fall

The site is several thousand feet from the mountain front, and no boulders from rock fall were observed at the surface of the site. Based on this, the hazard from rock falls is rated as low.

Snow Avalanche

A hazard from snow avalanches may exist due to proximity of the site to mountainous areas with south-, west- and north-facing slope aspects. Based on the distance of the site from the mountain front, the risk from snow avalanche is very low.

Radon

Radon comes from the natural (radioactive) breakdown of uranium in soil, rock, and water and can seep into homes through cracks in floor slabs or other openings. The site is located in a "High" radon-hazard potential area (Black, 1993). A high hazard rating indicates that indoor radon concentrations would likely be greater than 4 picocuries per liter of air, which is above the action level recommended by the Environmental Protection Agency. However, actual indoor radon levels can be affected by non-geologic factors such as building construction, maintenance, and weather. Indoor testing following construction is the best method to characterize the radon hazard and determine if mitigation measures are required. Given the proposed use of the development, radon gas may not pose a significant hazard.

Swelling and Collapsible Soils

Surficial soils that contain certain clays can swell or collapse when wet. Soils at the site appear to consist mainly of sand and gravel. A geotechnical engineering evaluation should be performed during the subdivision approval process to address soil conditions and provide specific recommendations for site grading, subgrade preparation, and footing and foundation design.

Volcanic Eruption

No active volcanoes, vents, or fissures are mapped in the region. Based on this, no volcanic hazard likely exists at the site and the risk to the project is low.

CONCLUSIONS AND RECOMMENDATIONS

Principal geologic hazards at the site are earthquake ground shaking and stream flooding. Lesser hazards from tectonic subsidence, debris flows, and indoor radon are also at the site. The following recommendations are provided to address these potential hazards:

- The proposed development should be designed and constructed to current seismic standards to reduce the potential ground-shaking hazard.

- A design-level geotechnical engineering study should be conducted prior to construction to: (1) address soil conditions at the site for use in foundation design, site grading, and drainage; (2) provide recommendations regarding building design to reduce risk from seismic acceleration; and (3) provide recommendations to reduce the risk from debris flows as needed.

- Site hydrology and runoff should be evaluated by the project civil engineer in conformance to Brigham City and Box Elder County development guidelines regarding stream flooding.

In summary, the site is considered suitable for the proposed development if the recommendations in this report are followed.

Availability of Report

The report should be made available to architects, building contractors, and in the event of a future property sale, real estate agents and potential buyers. This report should be referenced for information on technical data only as interpreted from observations and not as a warranty of conditions throughout the site.

LIMITATIONS

This investigation was performed at the request of the Client using the methods and procedures consistent with good commercial and customary practice designed to conform to acceptable industry standards. The analysis and recommendations submitted in this report are based upon the data obtained from compilation of known geologic information. This information and the conclusions of this report should not be interpolated to adjacent properties without additional site-specific information. In the event that any changes are later made in the location of the proposed site, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or approved in writing by the engineering geologist.

This report has been prepared by the staff of Western GeoLogic for the Client under the professional supervision of the principal and/or senior staff whose seal(s) and signatures appear hereon. Neither Western GeoLogic, nor any staff member assigned to this investigation has any interest or contemplated interest, financial or otherwise, in the subject or surrounding properties, or in any entity which owns, leases, or occupies the subject or surrounding properties or which may be responsible for environmental issues identified during the course of this investigation, and has no personal bias with respect to the parties involved.

The information contained in this report has received appropriate technical review and approval. The conclusions represent professional judgment and are founded upon the findings of the investigations identified in the report and the interpretation of such data based on our experience and expertise according to the existing standard of care. No other warranty or limitation exists, either expressed or implied.

The investigation was prepared in accordance with the approved scope of work outlined in our proposal for the use and benefit of the Client; its successors, and assignees. It is based, in part, upon documents, writings, and information owned, possessed, or secured by the Client. Neither this report, nor any information contained herein shall be used or relied upon for any purpose by any other person or entity without the express written permission of the Client. This report is not for the use or benefit of, nor may it be relied upon by any other person or entity, for any purpose without the advance written consent of Western GeoLogic.

In expressing the opinions stated in this report, Western GeoLogic has exercised the degree of skill and care ordinarily exercised by a reasonable prudent environmental professional in the same community and in the same time frame given the same or similar facts and circumstances. Documentation and data provided by the Client, designated representatives of the Client or other interested third parties, or from the public domain, and referred to in the preparation of this assessment, have been used and referenced with the understanding that Western GeoLogic assumes no responsibility or liability for their accuracy.

The independent conclusions represent our professional judgment based on information and data available to us during the course of this assignment. Factual information regarding operations, conditions, and test data provided by the Client or their representative has been assumed to be correct and complete. The conclusions presented are based on the data provided, observations, and conditions that existed at the time of the field exploration.

It has been a pleasure working with you on this project. Should you have any questions please call.

Sincerely,

Western GeoLogic, LLC

Bill D. Black, P.G.
Associate Engineering Geologist

LICENSED PROFESSIONAL GEOLOGIST
BILL DUANE BLACK
NO. 5224898-2250
STATE OF UTAH

Reviewed by:

Craig V Nelson, P.G., R.G., C.E.G.
Principal Engineering Geologist

LICENSED PROFESSIONAL GEOLOGIST
CRAIG V NELSON
5251804
STATE OF UTAH

E:\Western GeoLogic\PROJECTS\Earthtec Ogden\UDOT Brigham City - Earthtec - Ogden 2\UDOT Brigham City Geologic Hazards Recon - letter report.doc

ATTACHMENTS

Figure 1. Location Map
Figure 2. Air Photogeologic Map
Figure 3. Test Pit Logs

REFERENCES

Anderson, R.E., 1989, Tectonic evolution of the intermontane system--Basin and Range, Colorado Plateau, and High Lava Plains, *in* Pakiser, L.C., and Mooney, W.D., editors, Geophysical framework of the continental United States: Geological Society of America Memoir 172, p. 163-176.

Arabasz, W.J., Pechmann, J.C., and Brown, E.D., 1992, Observational seismology and evaluation of earthquake hazards and risk in the Wasatch Front area, Utah, *in* Gori, P.L. and Hays, W.W., editors, Assessment of Regional Earthquake Hazards and Risk along the Wasatch Front, Utah: Washington, D.C, U.S. Geological Survey Professional Paper 1500-D, Government Printing Office, p. D1-D36.

Black, B.D., 1993, The radon-hazard-potential map of Utah: Utah Geological Survey Map 149, scale 1:500,000, 12 p.

Black, B.D., Hecker, Suzanne, Hylland, M.D., Christenson, G.E., and McDonald, G.N., 2003, Quaternary fault and fold database and map of Utah: Utah Geological Survey Map 193DM, CD-ROM.

Boore, D.M., Joyner, W.B., and Fumal, T.E., 1993, Estimation of Response Spectra and Peak Acceleration from Western North America Earthquakes--An interim report: U.S. Geological Survey Open-File Report 93-509.

Clark, D.W., Appel, C.L., Lambert, P.M., and Puryear, R.L., 1990, Ground-water resources and simulated effects of withdrawals in the East Shore area of Great Salt Lake, Utah: Utah Department of Natural Resources Technical Publication 93, 150p.

Feth, J.H., Barker, D.A., Moore, L.G., Brown, R.J., and Veirs, C.E., 1966, Lake Bonneville—Geology and hydrology of the Weber delta district, including Ogden, Utah: U.S. Geological Survey Professi9onal Paper 518, 76 p.

Frankel, A.D., Peterson, M.D., Mueller, C.S., Haller, K.M., Wheeler, R.L., Leyendecker, E.V., Wesson, R.L., Harmsen, S.C., Cramer, C.H., Perkins, D.M., and Rukstales, K.S., 2002, Documentation for the 2002 update of the National Seismic Hazard Maps: U.S. Geological Survey, Open-File Report 02-420, 33 p.

Gwynn, J.W. (Editor), 1980, Great Salt Lake--A scientific, historical, and economic overview: Utah Geological Survey Bulletin 166, 400 p.

Jarrett, R.D., and Malde, H.E., 1987, Paleodischarge of the late Pleistocene Bonneville flood, Snake River, Idaho, computed from new evidence: Geological Society of America Bulletin, v. 99, p. 127-134.

Lund, W.R. (Editor), 1990. Engineering geology of the Salt Lake City metropolitan area, Utah: Utah Geological and Mineral Survey Bulletin 126, 66 p.

____2005, Consensus preferred recurrence interval and slip-rate estimates - Review of Utah paleoseismic-trenching data by the Utah Quaternary Fault Parameters Working Group: Utah Geological Survey Bulletin 134, 109 p.

Machette, M.N., Personius, S.F., and Nelson, A.R., 1992, Paleoseismology of the Wasatch fault zone--A summary of recent investigations, interpretations, and conclusions, *in* Gori, P.L., and Hays, W.W., editors, Assessment of regional earthquake hazards and risk along the Wasatch Front, Utah: U.S. Geological Survey Professional Paper 1500, p. A1-A71.

Miller, D.M., 1990, Mesozoic and Cenozoic tectonic evolution of the northeastern Great Basin, *in* Shaddrick, D.R., Kizis, J.R., and Hunsaker, E.L. III, editors, Geology and Ore Deposits of the Northeastern Great Basin:

Geological Society of Nevada Field Trip No. 5, p. 43-73.

O'Connor, J.E., 1993, Hydrology, hydraulics, and geomorphology of the Bonneville flood: Geological Society of America Special Paper 274, 83 p.

Oviatt, C.G., Currey, D.R., and Sack, Dorothy, 1992, Radiocarbon chronology of Lake Bonneville, Eastern Great Basin, USA: Paleogeography, Paleoclimatology, Paleoecology, v. 99, p. 225-241.

Personius, S.F., 1990, Surficial geologic map of the Brigham City segment and adjacent parts of the Weber and Collinston segments, Wasatch fault zone, Box Elder and Weber Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-1979, scale 1:50,000.

Sbar, M.L., Barazangi, M., Dorman, J., Scholz, C.H., and Smith, R.B., 1972, Tectonics of the Intermountain Seismic Belt, western United States--Microearthquake seismicity and composite fault plane solutions: Geological Society of America Bulletin, v. 83, p. 13-28.

Smith, R.B., and Arabasz, W.J., 1991, Seismicity of the Intermountain Seismic Belt, *in* Slemmons, D.B., Engdahl, E.R., Zoback, M.D., and Blackwell, D.D., editors, Neotectonics of North America: Geological Society of America, Decade of North American Geology Map v. 1, p. 185-228.

Smith, R.B. and Sbar, M.L., 1974, Contemporary tectonics and seismicity of the western United States with emphasis on the Intermountain Seismic Belt: Geological Society of America Bulletin, v. 85, p. 1205-1218.

Stewart, J.H., 1978, Basin-range structure in western North America, a review, *in* Smith, R.B., and Eaton, G.P., editors, Cenozoic tectonics and regional geophysics of the western Cordillera: Geological Society of America Memoir 152, p. 341-367.

____, 1980, Geology of Nevada: Nevada Bureau of Mines and Geology Special Publication 4.

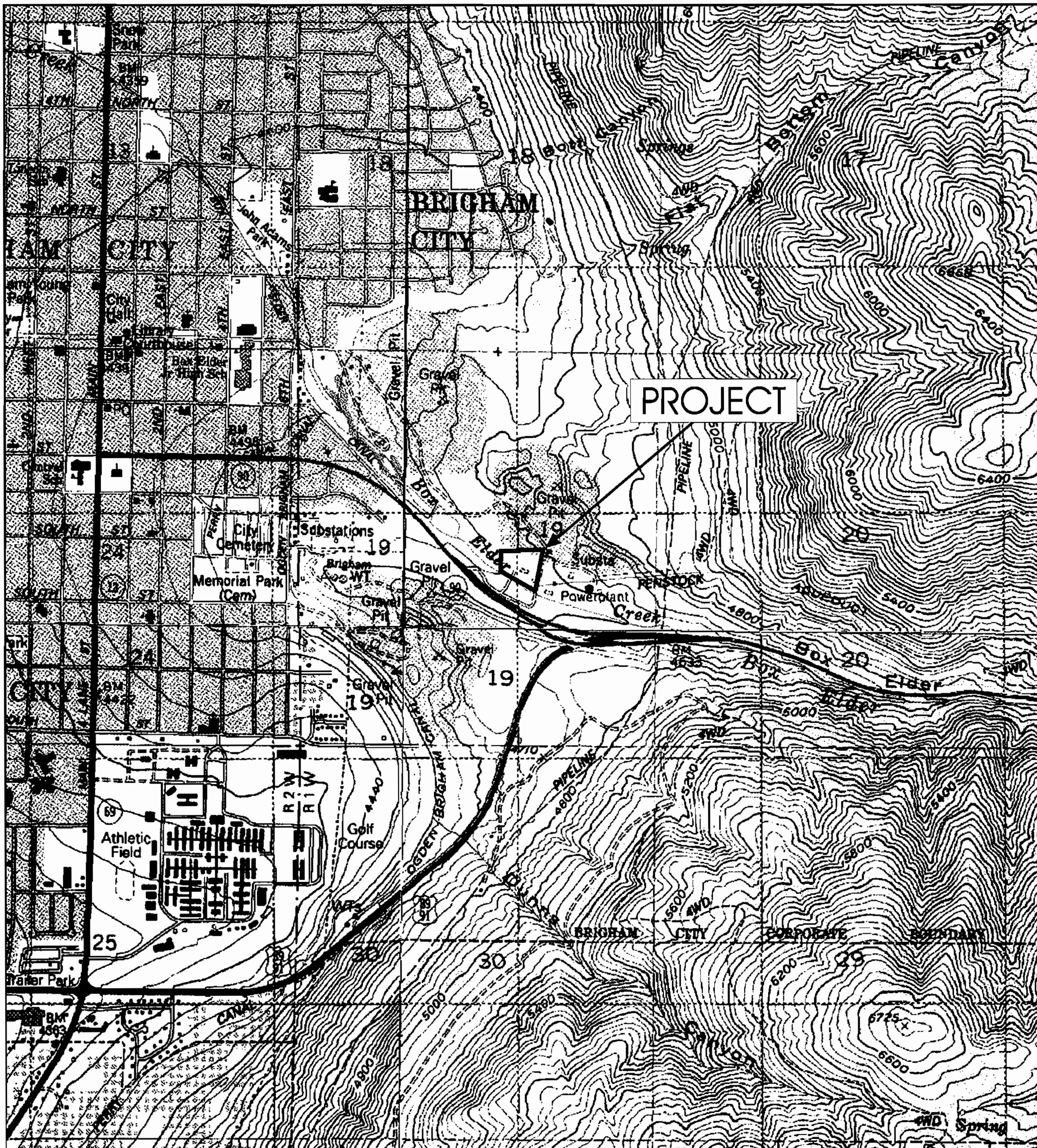
Stokes, W.L., 1977, Physiographic subdivisions of Utah: Utah Geological and Mineral Survey Map 43, scale 1:2,400,000.

____, 1986, Geology of Utah: Salt Lake City, University of Utah Museum of Natural History and Utah Geological and Mineral Survey, 280 p.

Utah Section of the Association of Engineering Geologists, 1986, Guidelines for preparing engineering geologic reports in Utah: Utah Geological Survey Miscellaneous Publication M, 2 p.

Zoback, M.L., 1989. State of stress and modern deformation of the northern Basin and Range province: Journal of Geophysical Research, v. 94, p. 7105-7128.

Zoback, M.L. and Zoback, M.D., 1989. Tectonic stress field of the conterminous United States: Boulder, Colorado, Geological Society of America Memoir, v. 172, p. 523-539.



Source: U.S. Geological Survey 7.5 Minute Series Topographic Maps, UT: BRIGHAM CITY, 1998; MOUNT PISGAH, 1991; MANTUA, 1991; WILLARD, 1992.

WESTERN GEOLOGIC

N
W E
S

Scale 1:24,000
(1 inch = 2000 feet)

LOCATION MAP

GEOLOGIC HAZARDS RECONNAISSANCE

UDOT - Brigham City Site
Brigham City, Box Elder County, Utah

FIGURE 1

Sources: National Aerial Photography Program, frame NAPP 5922 027; September, 1993; geologic mapping from Personius (1990).

WESTERN GEOLOGIC

N
W E
S

Scale 1:10,000
(1 inch = 833 feet)

AIR PHOTOGEOLOGIC MAP

GEOLOGIC HAZARDS RECONNAISSANCE

UDOT - Brigham City Site

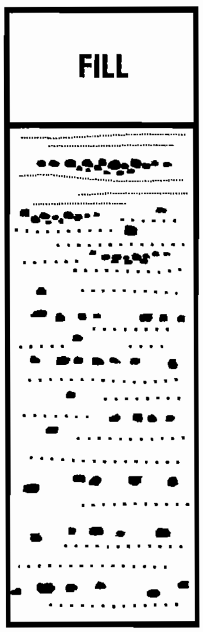
Brigham City, Box Elder County, Utah

FIGURE 2

Test Pit 1

Feet

0



1.5

Alluvium - gravelly sand to sandy g (SW/GW); contains thin fine sand le stained with iron oxide and discont gravel channels in upper part, dips about 15 degrees; gravel channel openwork with manganese stainin bedded; low density.

8.0

No water

st Pit 3

Alluvium - gravelly sand to sandy gravel (SW/GW); contains coarse gravel lenses with sandy matrix; low density; poorly bedded.

o water

Test pi

TEST PIT LOGS

GEOLOGIC HAZARDS RECONNAISSANCE

UDOT - Brigham City Site

Brigham City, Box Elder County, Utah

WESTERN GEOLOGIC

FIGURE 3